Clean and Green Technology

Defining the Cluster

Clean and green businesses do not form a traditional supply-chain-based industry cluster. Instead, the cluster includes all businesses involved in research and development technologies, manufacture of products, and provision of services related to sustainability and solving environmental challenges. Only a portion of clean and green businesses demand placement on industrial sites, and businesses defined as clean and green span a broad spectrum of industry sectors and employment opportunities.

The terms "clean" and "green" technology/economy are largely used interchangeably. Historically the "clean tech" was more all-encompassing than "green tech," as it was created by investors to describe asset classes of companies engaged in development and production of green technologies and processes; the latter comprised "green tech."[41] However, the widespread popularity of "clean tech" has blurred the definitions of these descriptors of green economy activities.

General discussions of the "green economy" are further confused by inclusion of two additional components: 1) businesses and homes that have a high potential for reduced environmental impacts through changing business practices and modified buildings; and 2) improved environmental sustainability through location within "location-efficient" sites (i.e., sites with transit access and built forms that encourage energy-efficient transportation decisions). These activities are among the drivers of the green economy, but the economic engine for innovation is the cluster of businesses within clean/green tech.

Overview of Global and National Existing Conditions and Trends

It is difficult to gauge the exact size and distribution of green and clean businesses throughout the world because of diverging definitions, measures, and the cross-industry nature of the cluster; instead, proxy measures exist. For example, according to a report by the Pew Charitable Trusts, clean energy investments in 2009 totaled $162 billion, with China's $34.6 billion leading the world versus the United States' second place $18.6 billion.[42] China's recent increases in investment have partly occurred in response to the nation's overwhelming domestic energy needs. The majority of clean energy investment occurs in the G-20 countries, but Turkey, Brazil, and China have posted the highest growth rates over the past five years.[43] The United States greatly lags numerous countries in public and private investment relative to GDP partly because of less aggressive clean energy generation targets.

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[41] Dikeman, Neal. "What is Clean Tech?" CNET.com. 10 August 2008.

[42] Pew Charitable Trusts, The. *Who's Winning the Clean Energy Race?: Growth, Competition, and Opportunity in the World's Largest Economies.* 2010.

[43] Breakthrough Institute and The Information Technology and Innovation Foundation. *Rising Tigers Sleeping Giant: Asian Nations Set to Dominate the Clean Energy Race by Out-Investing the United States.* November 2009.

The United States is a clear leader in clean and green economy venture capital investment, with Deloitte and CleanTech Group finding that North America accounted for 60 to 70 percent of total clean technology venture capital investment in recent years.[44] Venture capital investment is a good proxy for level of innovation within the green and clean economy since these investments are focused on innovative, highly-promising, and unique products. The high levels of venture capital investment indicate that the United States may serve as a major innovator in clean technology, but low costs and high populations in developing countries may result in offshore production and implementation of some resulting products.

Within the United States, California hosts the largest concentration of clean and green economy businesses and investment. According Pew Charitable Trusts, California drew 40 percent of global clean technology venture capital and the state led the nation in related technology patents.[45] Within California the largest sub-categories of green investment are Energy Generation, Energy Efficiency, and Transportation. The northeastern United States hosts the nation's second largest concentration of green economic activity.

Government incentives and investments help significantly drive green and clean business activity. The American Reinvestment and Recovery Act alone included $38 billion in clean energy-related programs and $20 billion in tax incentives. This package included grants to upgrade the electric grid, research and development clean energy sources, research advanced batteries (electric cars), weatherize homes, research mitigation of fossil fuel impacts, and electric car tax credits.[46] The Green Jobs Act of 2007 focused on developing a skilled workforce compatible with jobs in the green economy. Most developed nations are similarly incentivizing research and development in the clean and green technology sector.

Generally speaking, rapid and significant domestic growth is expected in jobs in the green industry cluster; projections vary, but few have attempted to quantify the tension between this job growth compared to loss or transformation of jobs in non-green sectors.

Bay Area Positioning

The potential for green business development is heightened by the Bay Area's concentration of capital and expertise, California investments and regulations that encourage green business development, and recent incentives and investment from the Federal government. Collaborative Economics' 2008 report *Clean Technology and the Green Economy*[47] found that the Bay Area leads California in number of green establishments, and slightly trails Southern California in

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[44] Cleantech Group, LLC. Press Release. January 26, 2010. Online at http:/cleantech.com/about/pressreleases/20090106.cfm.

[45] Pew Charitable Trusts, The. *The Clean Energy Economy: Repowering Jobs, Businesses, and Investments Across America.* June 2009.

[46] LaMonica, Martin. "Obama Signs Stimulus Plan, Touts Clean Energy." CNET.com. 17 February 2009.

[47] Collaborative Economics. *Clean Technology and the Green Economy.* Prepared for California Economic Strategy Panel. March 2008.

employment. The Bay Area also boasts a more diversified green business cluster, with energy generation and efficiency dominating less than in Southern California. Finally, the Bay Area benefits from its concentration of venture capital, as demonstrated by the presence of 44 of the Cleantech Group's top 100 world clean technology companies.[48]

Labor economists have expressed concern that green and clean job growth will emphasize research and development and service jobs over manufacturing; manufacturing opportunities are relatively limited since green manufacturing is still subject to the same national and global pressures as other manufacturing uses.[49,50] For example, Fremont solar energy manufacturer Solyndra—a company that has received extensive private and public investment—had been planning to expand its operations but recently reduced its manufacturing capacity as a result of competition by low-cost, high-volume Chinese producers of less advanced solar panels.[51]

In the long term, green job opportunities for blue-collar workers are more likely to be in on-site services such as construction, maintenance, or final assembly of energy generation components. Despite this long-term possibility, analysis by Collaborative Economics found that manufacturing and construction jobs made up 51 percent of California's green economy jobs in 2008, compared to 28 percent for professional, scientific, and technical services.

Site-Specific/Fremont Implications

Clean technology businesses and investments are heavily concentrated in Fremont and have high growth potential. Fremont has met with tremendous success in attracting clean technology companies and investment. According to the City's own data research, Fremont now has more than 20 clean technology firms; those firms attracted more venture capital in 2008 and 2009 than any other East Bay city, even after excluding large investments in Solyndra.[52] Fremont received $274 million of clean technology venture funding in 2008 and $331 million in 2009, ranking number one in terms of all other East Bay cities. This clean technology investment is largely driven by investments in Solyndra and Deeya Energy.[53] Fremont's major clean technology companies now include Solyndra (solar energy), Solaria (solar energy), and Tesla

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[48] City of Fremont. "Cleantech Sector Analysis and Economic Development Opportunities." PowerPoint. July 2010.

[49] Apollo Alliance. *Winning the Race: How American Can Lead the Global Clean Energy Economy.* March 2010. Pp 12.

[50] Joint Venture Silicon Valley Network. *Climate Prosperity: A Greenprint for Silicon Valley.* February 2009. Pp 13.

[51] Woody, Todd. "Solar-Panel Maker to Close a Factory and Delay Expansion." *The New York Times.* 3 November 2010.

[52] City of Fremont. "Cleantech Sector Analysis and Economic Development Opportunities." PowerPoint. July 2010.

[53] City of Fremont. "Cleantech Sector Analysis and Economic Development Opportunities." PowerPoint. July 2010.

Motors. Solaria expanded its operations in the Ardenwood area, but the South Fremont/Warm Springs Study Area provides significant land for expansion and is near to all three companies.

Biotechnology

Defining the Cluster

"Biotechnology," often abbreviated "biotech," includes any businesses engaged in the research and development of technologies that interact with biological organisms or processes to produce commercial products and applications. As such, the cluster includes both high-level scientific research activities and high-value manufacturing of resultant commercial products. Biotechnology includes the development of human medical applications as well as non-medical applications such as genetically-modified foods.

Biotechnology is a cutting-edge and research-dependent field that thrives in locations including major research universities and venture capital. Universities attract and produce high-skill researchers, and also provide initial product concepts through their research. These ideas are often commercialized through the formation of companies supported by the universities and venture capital. Alternately, well-established companies will engage in their own research and development and self-commercialize, or smaller companies will contract with large companies for production. Regardless of how the biotechnology is developed and produced, new products often undergo many years of extensive testing and regulatory approval before being sold. As a result, biotechnology companies require long-term working capital and are not quick-turnaround investments.

Overview of Global and National Existing Conditions and Trends

According to Ernst & Young's report *Beyond Borders: Global Biotechnology Report 2010,*[54] established concentrations of the biotechnology industry are located in the United States, Europe, Canada, and Australia, while China and India feature large, rapidly emerging biotechnology sectors. Small and large biotechnology companies alike compete on a global scale since product development occurs at globally-competitive institutions and companies, and manufacturing and distribution of products can be located worldwide. Global competition in all fields of biotechnology will intensify as India and China grow their educated workforces, emphasize development of cutting-edge research through government investments, and take advantage of their continued economic growth and low costs. These countries are moving from mere providers of services to research centers in their own right.

Within the United States, the largest biotechnology clusters are found in the San Francisco Bay Area and Boston regions. These regions formed the earliest concentrations of biotechnology companies in the 1970s and are distinguished by their large concentrations of universities, high-level research and development companies, and concentrations of venture capital. Major secondary but fast-growing biotechnology clusters exist in the San Diego, Raleigh-Durham, and Seattle regions, and stable concentrations exist in New York and Philadelphia because of the

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[54] Ernst & Young. *Beyond Borders: Global Biotechnology Report 2010.* 2010.

presence of large pharmaceutical and medical manufacturers.[55] Agricultural biotechnology clusters are concentrated in Wyoming, South Carolina, Wisconsin, and Montana. California includes concentrations in all major biotechnology categories except for agriculture.[56]

The United States' biotechnology industry continues to be healthy and poised for additional growth. Biotechnology employment grew by 15.8 percent between 2001 and 2008 to a total of 1.42 million jobs, rapidly outpacing overall employment growth. Approximately 90 percent of the industry's growth occurred in research and testing, thus generating high-skill, high-wage jobs. Future growth will depend on availability of venture capital, availability of government research investments, and education and attraction of high-skill workers.[57]

Bay Area Positioning

As mentioned above, the San Francisco Bay Area is one of the largest national and global concentrations of biotechnology. The region benefits from its inclusion of numerous research universities, research hospitals such as UC San Francisco, and the highest concentration of venture capital in the nation. Analysis by Collaborative Economics has shown that the Silicon Valley sub-region includes nearly 10,000 jobs in biotechnology—forming a concentration three times that of the nation overall—and over 30,000 total jobs in the broader life sciences.[58]

Looking forward, the greatest challenge to the Bay Area's biotechnology competitiveness comes from talent attraction and retention. The local biotechnology industry is well-established and dominant, but reports by Joint Venture Silicon Valley and other Bay Area economic development organizations, coupled with global growth trends of the cluster, indicate that it will become increasingly difficult to fill positions left open by retiring baby boomers. As with Silicon Valley's technology industry, biotechnology is dependent on domestic and international in-migration. Emerging biotechnology clusters elsewhere in the United States and the world may lead to these workers staying closer to home. Future competitiveness will require development of local and domestic talent, and possibly greater incentives for attracting global talent.

Site-Specific/Fremont Implications

Fremont is a competitive location for biotechnology companies, and life science companies in general. The City's 5,000 biotechnology and related life sciences jobs create a heavy concentration compared to the State.[59] However, Fremont is relatively distant from the Bay

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[55] Cortright, Joseph and Heike Mayer. *Signs of Life: The Growth of Biotechnology Centers in the U.S.* The Brookings Institution Center on Urban and Metropolitan Policy. 2002.

[56] Batelle Technology Partnership Practice. *Batelle/BIO State Bioscience Initiatives 2010.* Prepared for Biotechnology Industry Organization. May 2010.

[57] Ibid.

[58] Joint Venture Silicon Valley. *Special Analysis: Silicon Valley's Changing Industry Mix and Demand for Skills.* 2009.

[59] Economic & Planning Systems and Strategic Economics. *South Fremont/Warm Springs Area Studies: Baseline Market Analysis.* Prepared for the City of Fremont. October 2010.

Area's major research centers and venture capital providers. As a result, Fremont may be better positioned to capture biotechnology companies seeking to lower costs by locating in inexpensive land and buildings. Fremont can potentially attract cost-conscious smaller firms and large firms seeking land for expansion. The City also competes well based on its inclusion of high-quality housing and neighborhoods that are relatively less expensive compared to many Peninsula/Silicon Valley cities.

Fremont's life sciences business base expands well beyond narrow definitions of biotechnology, including a concentration of medical device companies. This diversity provides further flexibility to Fremont beyond biotechnology, given that nearly 13,000 Silicon Valley jobs are related to medical devices, even greater than the number of biotechnology jobs.[60] City staff state that Fremont competes well in attracting life science startup companies, with the successful ones often acquired by larger companies that are either kept in the City or absorbed into other facilities.

The Study Area holds potential to attract biotechnology and life science firms, but is a second-choice location compared to Ardenwood, which features easy access to the Dumbarton Bridge and, therefore, the high-skill workforce in cities such as Menlo Park and Palo Alto.

Logistics/Warehousing/Goods Movement

Defining the Cluster

This sector is comprised of businesses that are involved in the transport and storage of goods from their point of origin or manufacture to the point of consumption or end user. This sector includes businesses such as trucking, warehousing, wholesale trade and manufacturing (e.g., food and beverage manufacturing). These jobs provide relatively high wages with low educational requirements.

Overview of Global and National Existing Conditions and Trends

Over the past 50 years, the rise in globalization has resulted in a vastly more complicated and dispersed logistics network than previously existed. Goods that used to be produced locally are now produced in multiple components in several different countries before being assembled and shipped to market. Inexpensive labor overseas, inexpensive oil and improvements such as containerized shipping and other technological improvements in shipping have accelerated this trend.[61] This has led to a growth in the logistics/warehousing and goods movement industries in areas that serve as major trans-shipment points for goods such as Southern California and the Bay Area. Despite off-shoring of many manufacturing processes, the goods still need to be delivered to final consumers in the United States. With a major port and good highway

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[60] Joint Venture Silicon Valley.

[61] Corbett, James J. and Winebrake, James. Energy and Environmental Research Associates The Impacts of Globalisation on International Maritime Transport Activity: Past trends and future perspectives. November 2008.

connectivity to the western United States, the Bay Area still serves and important trans-shipment point for goods arriving from Asia and Mexico.[62]

Bay Area Positioning

These businesses are a vital part of the Bay Area economy because efficient goods movement is critical to the success of all sectors. The State has made the support and development of this industry a priority by fostering a collaboration between the California Business, Transportation & Housing Agency (BTH) and the California Environmental Protection Agency (Cal/EPA). In 2007 the agencies issued a joint *Goods Movement Action Plan* that laid out specific steps to protect the assets necessary to facilitate goods movement and address environmental challenges associated with it.[63] Because of assets important to goods movement including a major port, well-connected interstate highways and available facilities, the Bay Area was designated as one of the key areas where the collaboration should focus resources to protect these assets.

In addition, a 2008 MTC report on goods movement and land use identified industrial land in the East Bay I-80/880 Corridor from Richmond to Fremont as a key concentration of industrial land for the goods movement industry.[64] The report highlighted the fact that local land use decisions don't take into account the regional implications of converting industrial land to other uses such as residential or commercial. While industrial land uses may not be the "highest and best use" from a market perspective, over the long run, a lack of industrial land will hamper the economy and reduce the amount of goods that can be moved around and through the Bay Area.

The MTC report also measured key characteristics of the goods movement industry in the Bay Area. For example most goods movement jobs are business serving. They "sell their goods and services to other businesses, thereby supporting business activities in the central Bay Area and throughout the region." Goods movement "industries provide good-paying jobs with low barriers to entry." A large portion of the goods movement industry supports regional demand. This is demand that cannot be served by offshore companies. Employment in the goods movement industry is forecasted to grow by approximately 59 percent by 2035.[65]

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[62] NAIOP Research Foundation, Spencer, Curtis D. and Schellenberg, Steve, IMS Worldwide, Inc. Trends in Global Manufacturing, Goods Movement and Consumption, and Their Effect on the Growth of United States Ports and Distribution. September 2010.

[63] Business, Transportation and Housing Agency (BTH) and California Environmental Protection Agency (Cal/EPA) Press Release. January 11, 2007. Available online at http:/www.arb.ca.gov/gmp/docs/policy.pdf

[64] Hausrath Economics Group, Goods Movement/Land Use Project for the San Francisco Bay Area. December 2008.

[65] Ibid.

Site-Specific/Fremont Implications

Fremont and the Study Area in particular are well positioned to meet the needs of the logistics, warehousing and goods movement sector. Access to two major interstate highways, proximity to the Port of Oakland and a large workforce are all significant assets for this sector.

High-Speed Rail

Defining the Sector

This section discusses high-speed rail development and related opportunities to develop production, distribution, and/or repair facilities. These facilities could include train vehicle manufacturing and maintenance, signaling systems, technology research and development, parts manufacturing, etc.

The rail manufacturing and operations industry involves a complicated global supply-chain network that defies simple summary. Rail vehicles tend to be custom-built under unique contracts, resulting in flexible collaborations of vehicle and component makers to meet the contract's needs. High-speed rail manufacturing will involve collaborations of multiple companies, some of which lack specific expertise in high-speed rail.

Overview of Global and National Existing Conditions and Trends

The greatest concentrations of high-speed rail operations and companies are found in several European and Asian nations. The world's first high-speed rail system was developed in Japan in 1964, with European systems opening soon afterward. Today notable systems exist in Spain, Germany, Belgium, Britain, France, Italy, Turkey, Portugal, Switzerland, China, Taiwan, Japan, and South Korea.[66] China is a relative newcomer to high-speed rail—with its first line opened in 2008—but has already constructed several lines as part of a $300 billion rail upgrade and expansion plan. China is estimated to have more high-speed rail routes than the entire rest of the world by 2012.[67]

Only a handful of companies worldwide have experience with manufacturing high-speed rail trains, none of which is based in the United States. Europe's Siemens (Germany) and Alstom (France) are the most advanced manufacturers,[68] and other manufacturers include companies such as Talgo (Spain), Kawasaki Heavy Industries (Japan), Bombardier (Canada), CSR Sifang (China), and CNR (China).

The United States dedicated $8 billion in stimulus funds to high-speed rail in 2009, and in October 2010 the Department of Transportation awarded $2.4 billion for high-speed rail

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[66] James, Randy. "A Brief History of High-Speed Rail." *Time Magazine.* 20 April 2009.

[67] Richburg, Keith B. "China is Pulling Ahead in Worldwide Race for High-Speed Rail Transportation." *The Washington Post.* 12 May 2010.

[68] Gertner, Jon. "Getting Up to Speed." *The New York Times Sunday Magazine.* 14 June 2009.

development.[69] Until these commitments, the United States had all but ignored high-speed rail in the post-War period. Amtrak's Acela Express in the Northeast Corridor served as the nation's only (relatively meager) example.

Florida and California have the most extensively-developed plans for rail, with Florida likely to open the nation's first new high-speed rail line between Tampa and Orlando. California has planned its high-speed rail system since 1996, and in fall of 2008 voters approved a $10 billion bond measure to help fund construction of the approximately $40 billion system. California has since received $2.5 billion and $900 million in Federal funding for the system.[70, 71]

The United States' commitment to building high-speed rail has triggered significant interest from foreign companies and governments with expertise. These companies are likely to locate manufacturing facilities in the United States because of Buy American requirements. Political or practical expediency will probably result in partnerships between foreign manufacturers and domestic companies with experience building freight rail and traditional passenger rail. Thirty domestic and foreign manufacturers have committed to building or expanding United States facilities if selected for major rail projects.

A number of domestic and international rail manufacturers already have facilities in the United States, some of which may be retooled or expanded to accommodate high-speed rail manufacturing. According to the Duke University report *U.S. Manufacture of Rail Vehicles for Intercity Passenger Rail and Urban Transit,*[72] 20 relatively vertically-integrated passenger rail or locomotive manufacturers have facilities in the United States. Eight of these are domestic companies. Of those eight, three only manufacture locomotives (General Electric, Electro-Motive, Motive Power), and only one of the remaining firms—U.S. Railcar—has noteworthy potential for assisting in high-speed rail production.

Four rail manufacturing operations are located in California out of 35 nationally; most rail manufacturing occurs east of the Mississippi.[73] The four facilities are owned by: 1) Alstom in Mare Island, 2) AnsaldoBreda in Pittsburg, 3) Nippon Sharyo in San Francisco, 4) Siemens in Sacramento. All four facilities are related to passenger rail. Siemens and AnsaldoBreda co-located their United States headquarters at their facilities.

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[69] Lambert, Lisa and John Crawley. "U.S. Govt. Announces 2.4 Bln for High-Speed Rail." *Reuters.* 28 October 2010.

[70] Ibid.

[71] Weikel, Dan. "High-Speed Train Project to Receive at Least $731 Million in Federal Funds." *Los Angeles Times.* 26 October 2010.

[72] Lowe, Marcy, Saori Tokuoka, Kristen Dubay, and Gary Gereffi. *U.S. Manufacture of Rail Vehicles for Intercity Passenger Rail and Urban Transit.* Duke University Center on Globalization Governance & Competitiveness. 22 June 2010.

[73] Ibid.

Bay Area Positioning

General rail manufacturing is concentrated in the eastern United States, but the Bay Area is a competitive location for attracting high-speed rail manufacturing due to California's early lead in system development. While Florida's system will be built first, California's will likely be second and is much more extensive. Manufacturers would benefit from access to parts and supplies via West Coast ports.

Competition will be most intense between the Bay Area and the Los Angeles region, with each region hosting ports, existing manufacturing base, locations along the rail route, and industrial land supply. Los Angeles previously demonstrated the potential to attract companies based on rail investment by attracting a commitment from European manufacturer AnsaldoBreda to construct a 240,000-square foot manufacturing facility to produce vehicles for the County's transit agency and other customers (although the deal collapsed during negotiations).[74] An opportunity may have already been missed with Siemens, as the company has acquired 20 acres for a high-speed rail production facility adjacent to its existing light rail plant in the Sacramento area.[75]

Site-Specific/Fremont Implications

Fremont will need to vigorously compete against other cities if it is to attract high-speed rail manufacturing. Only a handful of high-speed rail-related manufacturing operations are likely to be needed in the United States, and the location of these operations will further determine where suppliers locate. The Study Area benefits from its available land and access to rail spurs that can provide parts shipped in via the ports. However, less expensive locations may be available in California, and a bidding war of public incentives may occur between cities.

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[74] Reston, Maeve. "Italian Firm Awarded MTA Contract Pledges to Build New L.A. Rail Manufacturing Plant with Union Labor." *Los Angeles Times,* L.A. Now blog. 25 September 2009.

[75] Clayton, Mark. "Companies to Build High-Speed Rail Cars in the US." *The Christian Science Monitor.* 19 February 2010.